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# Factors affecting the adoption of a land information system: An empirical analysis in Liberia

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ABSTRACT

This study adopted the diffusion paradigm to study the implementation and development of land information systems (LIS). Using a theoretical structural model based on the combination of three acceptance theories, this study identifies the underlying factors affecting the adoption of an LIS in Liberia. Participants included 102 public servants from different sectors. The methodology of Structural Equation Modeling (SEM) was used to analyze the impacts on the intention to adopt an LIS. The results indicated that the intention of individuals to use LIS was influenced by personal innovativeness, attitude and perceived behavior control toward LIS. The path analysis of pre-determinants to these crucial factors demonstrated that LIS system design that leads to an increased perception of usefulness and ease of use would contribute to positive attitudes. Based on the survey analysis, several behavior interventions and land information policy suggestions were proposed for the specific sector. Finally, limitations and future directions were discussed.

## 1. Introduction

Land-use policies reflect the manner in which the government wants to address land issues in sustainable development (Bennett et al., 2008; Hallett et al., 2003).Notably, such policy-making and governance activities, legal decisions, and administrative activities, such as land use cover/change monitoring and suitability assessments, cadastral management, and urban and landscape planning, are difficult tasks that require the comparison of land characteristics, environmental factors and socio-economic cultural information for different land utilization types (FAO, 1995; Ho and Rajabifard, 2016). Contemporary information technology advances, such as land information systems (LIS), 3D cadastre systems and remote sensing surveys, also known as geospatial information communication technology (Geo-ICT), provide immense benefits for land resource management and policy making (Pilehforooshha et al., 2014; Tayyebi et al., 2016; Terres et al., 1995). At the regional and national levels, new information technology and collaborative work methods increase the efficiency of land resource administration and spatial decision support through the potential for networking (Dhakal, 2016; Evans et al., 2006; Hale, 2011; Hallett et al., 2003; Romano et al., 2015).

Undoubtedly, adequate information is important to land-use decision-making, since poor information might lead to misguided policies on land-resources management and environmental protection. Thus, acquiring land-related information through information technology innovations is an absolute requirement when developing a land-use policy agenda that reconciles economic development with ecosystem conservation (Saroinsong et al., 2007; van der Horst, 2006; Wastell,2006). Compared with time-consuming operations conducted using traditional, manual methods, advanced Geo-ICT should increase job performance in both the public and private sectors. The implementation of LIS results in decreased land disputes, improved responsiveness to public enquiries, and cost savings over existing procedures. LIS also generate increased revenues, not only through traditional avenues, such as taxes but also through new avenues such as up-to-date map production and publication. However, it should be noted that the overall success of LIS implementation depends on users' acceptance; it is that, rather than the technology *per se*, that ultimately determines increases in productivity and job performance (Badurek, 2009; Davis, 1989; Kalantari et al., 2015). If users do not accept LIS, or if the system does not achieve widespread adoption, the implementation of LIS will be ineffective, and the LIS project will be a failure.

As the software technology migrated from scripts to objects, new advances accelerated the rate of Geo-ICT change (Peters, 2014). Early GIS systems were developed in the context of desktop environments, client-server arrangement, and centralized management systems. For instance, the servers can enable remote user access to centrally managed GIS desktop applications. With the appearance of web-technology, Service-Oriented Architecture and Cloud Computing Platform Architecture, contemporary GIS/LIS environments enable land sectors to

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publish LIS information products to web browser. LIS is becoming far more distributed and using cloud based services for better integration and sharing of geospatial data. Although the new advances in software move technology forward at an increasingly rapid pace, the diffusion of GIS/LIS innovation in some developing countries is rather slow. For instance, herein, in the Republic of Liberia, there is no system to record and manage land rights information (Liberia Land Authority, 2017).

Several factors impede users from accepting and using geo-spatial technology (Badurek, 2009; Karikari et al., 2005; Nedović-Budić and Godschalk, 1996; Rogers, 2001),especially in developing countries where the spatial information infrastructure is still in early phases of development. Previous studies have indicated that developing countries have to deal with more problems than do developed countries due to the digital divide (Erica, 2016; Mirda et al., 2016). Understanding the factors that influence Geo-ICT or LIS diffusion is crucial for land administrators to better deploy and manage their IT resources to offer the advantages of efficiency gains, information sharing, better communication and faster knowledge acquisition for land-use policy making. However, despite the widespread use of Geo-ICT in developing countries, the actual process of deciding to implement LIS does not draw much attention in current land-use management research (Berisso and de Vries, 2010). For Liberia, although recently the National Bureau of Concession starts to use client-server management system as well as web-GIS for the mining cadaster, GIS/LIS presents to be a novelty for those land administration sectors. Hence, to develop strategies and options for a land information and administration system is becoming an important issue (Liberia Land Authority, 2017).

The primary objective of this study was to explain the factors that influence Geo-ICT-based LIS acceptance in land-related sectors in the Republic of Liberia. In this paper, we introduced and developed a combined model based on the theory of planned behavior(TPB), the technology acceptance model (TAM) and the diffusion of innovation theory (DOI) as a framework for investigating the vital links in employees' LIS usage intentions. Such understanding is needed to determine whether the concerns are raised about poor LIS adoption and IT use are correct and, if so, to understand why these occur and how to remedy them. To our knowledge there is no published quantitative research into the diffusion of LIS, despite Geo-ICT being of paramount importance in land administration (Berisso and de Vries, 2010; Eria and McMaster, 2016; Nedović-Budić and Godschalk, 1996; Staal et al., 2002). Based on this analysis, we discuss enforcing rules from an IT standpoint and show how information strategies can be implemented and enforced to help organizations better allocate LIS resources in Liberia, with a view toward increasing the level of LIS adoption in land-use sectors. Finally, the constraints on and impacts of land-information policy are discussed, along with the research limitations and guidance for further research.

## 2. Research background

### 2.1. Technology innovation and land-use management

Technology innovation and diffusion is not a new concept for land-use management. In fact, the contemporary leading theory of DOI can be traced to agricultural innovations, such as hybrid seeds, new equipment, biological/chemical developments and land-use conservation measures, in various parts of the United States in the early years of the last century (Griliches, 1958; Lybbert and Sumner, 2012; Robinson, 1985; Ryan and Gross, 1943). Not surprisingly in an age when agricultural technology was advancing rapidly, examining how independent farmers adopted new innovations was important to the development of agriculture and home economics. As a critical factor of agricultural production, land-related technology innovations are also important, especially from the perspective of individual farmers, because they can increase agricultural production and crop yields and enhance precision agriculture and conservation measures (Bewket, 2007; Sattler and Nagel, 2010; Van Hulst and Posthumus, 2016).

Land-use management activities are a cooperative process between local governments and land owners. In addition to farmers adopting new land-use ideas and technologies to promote sustainable development, governments need to pursue sustainability goals at the regional and national levels. LIS, a computerized system that manages land-related data, is a technological innovation for many governmental departments and agencies. With the rapid pervasion of information technology into land administration, researchers have endeavored to develop a general-purpose computer "mapping" LIS to store, collect and analyze data about land usage. From the first geographical information system (GIS), designed for a Canadian land inventory in the 1960s, to 3D simulation and visualization modeling in recent years, advanced geospatial technologies and standards are continuously being developed and introduced into land management (Ho and Rajabifard, 2016; Kalantari et al., 2015; Roberts et al., 2009; Tomlinson and Toomey, 1999). However, researchers have paid little attention to evaluating the LIS diffusion process, asking questions about the organizational requirements for Geo-ICT implementation in land-use sectors, and so on. Still, the diffusion of Geo-ICT into land-use planning activities has been limited by barriers that can restrict its successful implementation in the public sector.

The diffusion process of choosing to adopt an innovation can be decomposed into a series of five phases which passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision (Rogers, 2005). Diffusion researchers believe that a population can be broken down into five different segments, based on their propensity to adopt a specific innovation: innovators, early adopters, early majorities, late majorities and laggards. New innovations adoption process usually begins with a tiny number of innovators (Moore, 2002), the innovation must be accepted by a sufficient number of adopters. Therefore, a deeper understanding on what the adopters' beliefs, attitude and decision about the spatial technology innovation will provide useful information for strategies designed to encourage adoption behaviors for successful diffusion.

Individual adoption of geographical information technology innovations was a complex process resulting from many factors, which included technological constraints and human factors regarding system use (Masser and Campbell, 1996).In the context of information technology innovation, researchers came to recognize that users' technology acceptance and adoption was the pivotal factor in determining the success or failure of any information technology project (Davis, 1989). Over the past several decades, a significant body of research has been imported from other disciplines (e.g., psychology and behavioral science) to explain why a certain technology is (or is not) adopted in the workplace. These theories include the theory of reasoned action (TRA), the theory of planned behavior (TPB) (Fishbein and Ajzen, 1975), social cognitive theory (SCT) (Bandura, 1986), the technology acceptance model (TAM) (Davis, 1989), diffusion of innovation theory (DOI) (Moore and Benbasat, 1991)and the decomposed TPB (Taylor and Todd, 1995), which indicated that the internal beliefs of the constructs in the TPB had linkages with the constructs in other models.

Adopting LIS in land administration is both a solution and a problem in itself. Undoubtedly, LIS is paramount to land management since sound LIS linked to geospatial data delivers a range of benefits to stakeholders (Sattler and Nagel, 2010). The United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) has proposed that more work is needed to consider geographical information management, which has greatly assisted with land governance and management (UN-GGIM, 2015). Just as agricultural innovations benefit sustainable development goals, Geo-ICT usage as a tool in land-use sectors should increase the efficiency of land management (Martínez et al., 2013). The acceptance of Geo-ICT is determined by socioeconomic, institutional and environmental factors. Apart from the